A Brief History of Biophysics at

by Leo E. Lipetz

Earliest Glimmer

About 1910 a professor of physics at The Ohio State University, Charles A. Sheard, became interested in the physics of vision. He organized courses in what is now called physiological optics and in optometry. These led to the founding in 1914 of a Division of Optometry. Dr. Sheard left the University about 1920 and a few years later founded a biophysics group at the Mayo Clinic. It was because of Sheard's pioneering that vision research became, and has remained, a unique strength of this university.

Abortive Start

Professor Fred A. Hitchcock of the Department of Physiology early became interested in Biophysics and in 1949 was made head of an Institute of Biophysics. This was purely a discussion group intended to bring together the faculty interested in Biophysics. The Institute attracted little support and was abandoned a few years later.

Biophysics in the Physiology Department

About 1951 a former student of Fred Hitchcock's, Ralph W. Stacy, was added to the faculty of the Physiology Department. Stacy was interested in biophysics and was very energetic. He introduced a course in biophysics and an instrumentation course. In 1953, Norman A. Coulter, Jr. joined that department, and being interested in biological control systems, helped with the Biophysics teaching. In 1954, a biophysicist, Leo E. Lipetz, was brought into the Department of Ophthalmology to do research in vision. In 1955 he volunteered to help with the teaching, and introduced a course in electrophysiology. Assistance was also volunteered by another biophysicist, Richard W. Stow, who had been brought into the Department of Physical Medicine to conduct research.

In 1956, with the encouragement of Dean Doan of the College of Medicine, these four men (Stacy, Coulter, Lipetz, and Stow) were set up as a Division of Biophysics in the Department of Physiology - with no budget. Stow and Lipetz were given courtesy appointments in Physiology. All four had to donate their time and equipment for the teaching of biophysics.

Despite these handicaps, this biophysics program had trained about six Ph.D's by 1957 and four M.Sc.'s and three Ph.D's between then and 1961. See attached list of graduates. But there were real problems. First, the students had to meet all the requirements of the Physiology Department as well as those in biophysics, which extended their study time one or two years. Second, because of the paucity of biophysics

teachers, the students received training in only quite limited aspects of biophysics. Third, their training tended to be descriptive rather than quantitative and to be lacking in the more sophisticated aspects of the physical sciences. The Division personnel made several attempts to get support for improving the program with additional staff, but were turned down by the University administration.

Interdepartmental Biophysics Program

In the meantime, a few other biophysically-inclined scientists had joined other departments, and in late 1960, a group sparked by Richard C. Nelson of Physics and Quentin Van Winkle of Chemistry asked that an interdepartmental biophysics program be formed.

In March 1961 Dean Everett Walters of the Graduate School set up a Committee on Biophysics. It consisted of (alphabetically): Lipetz (then in the Insitute for Research in Vision), Nelson, Stacy, Carroll A. Swanson of the Botany Department, Van Winkle, and Assistant Dean Edward Q. Moulton of the Graduate School. They agreed on a formal interdepartmental program, and on course offerings to be furnished in biophysics, and in September 1961 asked that the program be established. In November 1961, the Curriculum Committee of the Graduate School approved in principle the concept of an Institute of Biophysics. In March 1962 that committee approved the Biophysics program, and recommended "that, if this program be approved, an effort be made to attract a qualified biophysicist to provide the necessary leadership of the Interdepartmental Biophysics Committee and that the Dean of the Graduate School be responsible for the selection and appointment of this person".

In June 1962, the Council on Instruction gave its approval to the request of the Graduate School to establish a program in Biophysics leading to the master of science and doctor of philosophy degrees. Approval was also given to the new courses requested for this program.

So there was the Graduate School with an approved program, an eager Biophysics Committee, and no budget for it!

The Lean Years

The new Graduate School Biophysics program opened in the autumn of 1962. Some graduate students who had been in Physiology's Biophysics Division transferred to the new program. A few new students entered the program. The participating faculty members donated of their time to advise the students and teach the old biophysics courses. No new courses were introduced because no one was given paid time for that. As 1962 drifted into 1963 and then into 1964 the Biophysics Committee members became discouraged. Swanson resigned and was replaced by John Gander of Agricultural Biochemistry. Stacy left the University and was replaced by Coulter. Coulter left the University and was replaced by Stow. Gander left the University and wasn't replaced.

Nelson, as Chairman, and with the approval of the Biophysics Committee, discouraged further students from entering the program.

The Institute Problem

In the meantime a change of OSU administrators had led to a change of policy regarding the powers of Institutes in the University. It was ruled that faculty appointments could not be made by Institutes and that their faculty members would have to find appointments in academic departments. The Institute for Research in Vision at that time had as faculty, Professor H. Richard Blackwell, its Director; Associate Professor Lipetz, Associate Professor David G. McConnell, and Assistant Professor Stanley W. Smith. Both Lipetz and Smith were up for promotions, but there was no longer any administrative procedure by which this could be handled and for two years nothing was done about it. Morale in the Institute was very low and work lagged.

The OSU Academic Board was aware of the deteriorating situations in the Biophysics program and the Institute for Research in Vision. They attempted to solve both problems by proposing, under the auspices of Dean Fuller, to combine the two groups into a Division of Sensory Biophysics, with or without other biophysics, under the College of Arts and Sciences. A formal proposal was circulated in June 1964, but no action was taken because of the objections of the Department of Physiology, which under a new chairman, was considering reviving its biophysics program.

Early in 1965 Lipetz prepared to move to another university. The Board persuaded him to stay on the promise that a strong biophysics program would be started and the tenure situation solved. As the start of such a program Lipetz and Smith put together a new biophysics course covering epistemology, measurement theory, control theory, and modeling theory for presentation in Autumn 1965.

The Division of Biophysics, Graduate School

One of the factors holding up action was the question of the administrative unit in which to place biophysics. The Board was hoping that a College of Biological Sciences would soon be created and wanted biophysics there. In late September 1965 the Board decided, as a holding operation, to make biophysics a Division in the Graduate School as of October 1, 1965. They moved the appointments and salaries of the four faculty members of the Institute for Research in Vision into this new Division. The Board asked Lipetz to be Acting Chairman of the Division and assigned the Division a budget and an office.

During the first year of the Division (1965-66) a total of four quarters of new biophysics courses were introduced: two quarters of the theory course by Smith and Lipetz, taught as Biophysics 800a, 800b; a seminar on psychophysical theory taught by Blackwell as Biophysics 701a; a seminar on the molecular basis of genetics taught by Van Winkle as Biophysics 701b. In addition, three quarters of the Division seminar, Biophysics 700, were conducted by McConnell.

The Division of Biophysics started with eight enrolled graduate students. At the start of the year each student was isolated - getting intellectual stimulation only from his professor and possibly one or two other students. A common gathering place was provided in the Division's library-reading room, where they held impromptu group discussions. An electronic calculator was kept available in the reading room, and students and faculty learned how to set up simple computer programs on it. A Malmstadt-Enke electronics teaching lab was acquired so that students could, on their own, use the lab to learn electronic instrumentation.

The Division of Biophysics, College of Biological Sciences

The Division of Biophysics was transferred from the Graduate School to the newly created College of Biological Sciences as of July 1966. Its faculty consisted of L. E. Lipetz, Professor and Acting Chairman; H. R. Blackwell, Professor; and Associate Professors D. G. McConnell and S. W. Smith. Also assisting WOC (without compensation) were Professor Emil Bozler of Physiology, Professor Quentin Van Winkle of Chemistry, Associate Professors Richard W. Stow of Physical Medicine and Philip B. Hollander of Pharmacology, and Professor Richard O. Moore of Agricultural Biochemistry (later replaced by Professor Junius Snell). This faculty spent much time in designing a biophysics teaching program that made maximum use of the resources already existing at OSU. This led to the program which was accepted by College and University and became that of the Academic Faculty of Biophysics.

The Academic Faculty of Biophysics

As part of the reorganization of the College of Biological Sciences, the Division of Biophysics was dissolved and an enlarged graduate biophysics program was begun July 1967 as the Academic Faculty of Biophysics in the College. Biophysics was joined WOC in October 1967 by Professor Richard M. Hill of Optometry and Professor Samuel A. Corson of Psychiatry. It was joined WOC in October 1968 by Associate Professor Gareth E. Gilbert of Population and Environmental Biology, and in January 1969 by Associate Professor Rothstein of Computer and Information Sciences.

The salaried faculty in Biophysics was increased by the appointments of three assistant professors: Joseph Y. Cassim in February 1968, Karl Kornacker in July 1968, and Carl Ingling (60% time) October 1968. Dr. Cassim's specialty was molecular biophysics, Dr. Kornacker's was theoretical biophysics, and Dr. Ingling's was visual psychophysics. Dr. Ingling's remaining 40 percent appointment was in Optometry.

Graduate Teaching Program

The expanded Biophysics faculty continued to revise the teaching program during 1967-69 to remove administrative barriers to the full use of University resources by the Biophysics students and to ensure high quality of training. At present great flexibility is allowed in the formation of a study program for each graduate student. The responsibility for adequacy

of the study program and examination is given to the study advisory committee appointed for each student. Emphasis was placed on individual studies and laboratory projects by each student with various members of the faculty. As of 1969 eighteen different courses had been approved and were taught. An undergraduate course was started in 1968-69, and the participating faculty outnumbered the students 16 to 4.

A bioengineering program that started in Electrical Engineering about 1967 had somewhat similar aims. Their courses and the Biophysics courses were designed to complement each other, with lecturers being regularly exchanged between the two programs.

Physical Facilities

In the Winter quarter of 1966 room 200 Lord Hall was renovated for the use of Biophysics. It was given new ceilings, lighting and paint, and (oh, joy!) equipped with air conditioners. The space was divided into a general office, a chairman's office, and a library-conference room. The faculty of Biophysics continued to use the same offices and laboratories as before. Blackwell, Lipetz, McConnell and Smith had theirs in the Institute for Research in Vision, at the Research Center.

In the Winter quarter of 1968, Cassim was given a refinished laboratory, room 112, in Edith Cockins Hall. In the summer of 1968 Ingling was given an office and laboratory in the Institute for Research in Vision, and Kornacker was given an office, room 107A, in Edith Cockins Hall.

Future Plans

The development of the present Biophysics program is planned around a unifying theme, the physical basis of behavior. This was chosen because it is expected to be the leading biophysical research trend of the next two decades. The faculty of the program all have this as a common research interest, though they work at levels of structural organization ranging from molecules to the whole organism.

The original plan called for the addition of eight FTE faculty to provide the competences needed for a self-sustaining, strong program. Already 2.6 FTE positions have been filled. The 1969-71 plan for further development was approved at the College and University levels, but not funded by the State Board of Regents. It is anticipated that another full-time faculty member will be added in 1970-71.

A new building, the Graduate Research Center for Biological Sciences, is expected to be ready for occupancy in mid-1970. At that time the Biophysics office will be moved there from Lord Hall and Cassim and Kornacker will move there to offices and laboratories from Edith Cockins Hall. Biophysics will gain about 7,100 square feet, for a total of 8,100. This will provide laboratories for seven of the faculty, six student research laboratories; offices for eight faculty members, the chairmen, four secretaries, 24 graduate students, and 10 postdoctoral fellows. It also will include a darkroom; animal quarters; wood, metal and electronics

shops; a reading room, and a seminar room. Funds have been provided to equip the facilities and offices and a number of the laboratories.

In Spring 1969 an application was made for a National Institutes of Health training grant to help build up the Biophysics graduate training program. It is expected that Biophysics will also be an intergral part of the proposal to the National Science Foundation for a University Science Development award.

Accomplishments

The faculty associated with the Biophysics program have been very active in their research. (See their publication lists in the appendix.) During the past fiscal year they brought in outside funds totaling over $350,000 (direct costs) in support of that research.

The faculty has been active professionally. Two faculty members serve on international professional committees (HRB, SAC), three on national professional committees (HRB, LEL, JR), and four on federal scientific advisory groups (HRB, RMH, LEL, SWS).

A number of students have already been given a head start in the developing field of the biophysics of behavior. Theirs will be the real measure of the success of this program. And this will be clear well before the next centennial of the University.

APPENDIX B

Major Publications of Faculty

H. Richard Blackwell, Professor

Blackwell, H. R. and Blackwell, O. M. Rod and Cone Receptor Mechanisms in Typical and Atypical Congenital Achromatopsia. Vision Research, 1, 62-107.
Blackwell, H. R. and Blackwell, O. M. Visual Resolution and Contrast. Abbilden and Sehen Vorabdruck der Vortrabe, VI. Int. Kongress fur Optic, Munich, 32-33.
Blackwell, H. R. Neural Theories of Simple Visual Discrimination. J. Opt. Soc. Amer., 53. 129-160.
Bredemeyer, H. G., Wiegmann, O. A. Bredemeyer, A. and Blackwell, H. R. Radiation Thresholds for Chorioretinal Burns. Air Force Systems Command. Tech. Doc. Rrt. AMRL-TDR-63-71, p. 78.
Blackwell, H. R. Discussion: Competing Theories of Receptor Excitation. Psychol. Bull 61, 4, 268-269.
And about 240 additional publications.

Emil Bozler, Professor

Bozler, Emil Control of the contractile mechanism of smooth and cardiac muscle, Am. J. Physiol. 215: 509512, 1968.
Bozler, Emil Role of Calcium in Initiation of activity of smooth muscle, Am. J. Physiol. 216: 671674, 1969.
And about 70 additional publications.

Joseph Y. Cassim, Assistant Professor

Cassim, J. Y. Biochem. Biophys. Research Communs., 26, 58 (1967).
Cassim, J. Y. Federation Proceedings, 27, 338 (1968).
Cassim, J. Y. Biochem. Biophys. Acta, 168, 463 (1968).
Cassim, J. Y. Biochemistry, accepted for publication (1969).
And about 3 additional publications.

Samuel A. Corson, Professor

Corson, S. A., Neuroendocrine and behavioral response patterns to psychologic stress and the problem of the target tissue in cerebrovisceral pathology, Ann. N. Y. Acad. Sci. 125: 890-918, 1966.
Corson, S. A., Conditioning of water and electrolyte excretion. In: Endocrines and the Central Nervous System Res. Publ. Ass. Nerv. Ment. Dis., Williams and Wilkins, Baltimore 43: 140-199, 1966.

Corson, S. A., Cholinergic and Adrenergic factors in conditioned and unconditioned responses to nociceptive stimuli in dogs with different typologic characteristics. Abhand. Deut. Akad. Wiss. Berlin, Kl. Med. No. 2: 17-32, 1966.

Corson, S. A. and E. O. Corson, The interaction of exteroceptive and interoceptive feedback mechanisms in the control of the body water economy. Proc. Symp. on Cybernetic Aspects of Integrative Brain Activity, XVIII Intl. Congr. of Psychology, Moscow, USSR, p. 65-86, 1966.

And about 100 additional publications.

Gareth E. Gilbert, Associate Professor

Gilbert, G. E., Basic ecological principles as related to population explosion. Ohio J. Sci. 68: 214-218.

Gilbert, G. E., Biological survey of Ellsuath Land, Antarctica. Antarctic Journal IV (4), July-August.

And about 35 additional publications.

Richard M. Hill, Professor

Hill, R. M. and Goodwin, H., Visual receptive fields of the marsupial, Didelphis virginiana, Proc. Intern. Union of Physiol. Sci., Vol. VII. XXIV International Congress Washington, D. C., 1968, p. 192.

Arden, G. B., Hill, R. M., Ikeda, H., Receptive fields of rabbit visual cortex, Proc. Brit. Physiol. Soc. 14, Jan. 1967, C. 16, and J. of Physiology 189: 73P 1967.

Hill, R. M., Receptive field properties of the superior colliculus of rabbit, Proceedings of the XXIII International Congress of Physiological Sciences, Tokyo, 1965.

Fischer, R., Hill, R. M., Warshay, D., Effects of the psychodysleptic drug psilocybin on visual perception. Changes in brightness preference, Experientia 25: 166, 1969.

And about 40 additional publications.

Philip B. Hollander, Professor

Sympathomimetic effects of acetaldehyde on the electrical and contractile properties of isolated left atria of guinea pigs. With M. Walsh and E. Truitt. J. Pharmacol. Exp. Therap., in press

A mechanism of quinidine-induced changes in the contraction force of guinea pig atria. With H. R. Besch. Drugs and actions, in press.

An electropharmacological comparison between quinidine and dihydroquinidine. With H. R. Besch, Arch. Internat. Pharmacol. Therap., in press.

Preparation of open-tip potassium and sodium-selective intracellular electrodes. With J. C. Roch. Submitted to J. Appl. Physiol., 1969.
And about 40 additional publications.

Karl Kornacker, Associate Professor

Kornacker, K. A Theory of Inherently Macroscopic Processes with Application to Heat & Active Transport. Nature, 219, pp. 1283-1284, 1968.
Kornacker, K. Physical Principles of Active Transport and Electrical Excitability. pp. 39-57 in, Dowben. R. M., Ed. Biological Membranes. Boston: Little, Brown Co., 1969.
Kornacker, K. Toward a Physical Theory of Self Organization, in press.
Kornacker, K. Cognitive Processes in Physics and Physiology, in press.
And about 5 additional publications.

Leo E. Lipetz, Professor

Lipetz, L. E. The flow and use of information in nervous systems, in Computer and the Brain, Prentice-Hall, in press, 1969.
Lipetz, L. E. The relation of physiological and psychological aspects of sensory intensity, in Handbook of Sensory Physiology, Vol. 1, Springer-Verlag, in press, 1969.
Lipetz, L. E. The transfer functions of sensory intensity in the nervous system, Vision Research, in press, 1969.
Lipetz, L. E. Electrical impedance of normal frog and human eyes, Vision Research Supplement, Clinical Electroretinography, Nov. 1966.
Lipetz, L. E. Information processing in the frog's retina, AMRL-TR-65-24, (AD 614249), Feb. 1965.
And about 30 additional publications.

David G. McConnell, Associate Professor

McConnell, D. G. The isolation of bovine retinal outer segment fragments. J. Cell Biol., 1965, 27, 459.
McConnell, D. G. Studies on the electron transfer system. LXV. Formation of membranes by purified cytochrome oxidase. J. Biol. Chem., 1966, 241, 2373.
McConnell, D. G. Preliminary observations on the lipids of bovine retinal outer segment discs. Nature, 1967, 212, 1366.
McConnell, D. G. The light-induced proton uptake in bovine retinal outer segment discs. J. Biol. Chem., 1968, 243, 5820.
McConnell, D. G. Studies on the ion-permeability of the bovine retinal outer segment. I. Preliminary observations. Biochem. Biophys. Acta, 1968, 163, 117.
And about 30 additional publications.

Jerome Rothstein, Professor

Rothstein, J. Probability of Existence of Self-Reproducing Units, Bull A.P.S. II, 14, pp. 504-5 (abstract).
Rothstein, J. Toward a Biostatistical Thermodynamics, Biophys. Jour 9 Society Abstract p. A-101 (abstract).
Rothstein, J. Roles of Energy and Entropy in Molecular Cybernetics, Biophys. Jour 8 Society Abstract p A-34.
Rothstein, J. Excluded Volume Effects as the Basis for a Molecular Cybernetics, pp. 229-245, Cybernetic Problems in Bionics, Gordon & Breck (1968) ed. by H. L. Oestreicher and D. R. Moore.
And about 130 additional publications.

Stanley W. Smith, Associate Professor

Baumgardt, E. and Smith, S. W. Facilitation Effect of Background Light on Target Detection: A Test of Theories of Absolute Threshold. Vision Res. Vol. 5, pp. 299-312, 1965.
Baumgardt, E. and Smith, S. W. Reply to Nachmias Concerning Interpretation of a Study to Test Theories of Absolute Threshold, Vision Res. Vol. 6, pp. 117-118, 1966.
Baumgardt, E. and Smith, S. W. Comparison de la sensibilite des cones et des batonnets de l'oeil humain. C. R. Acad. Sc. Paris, t. 264, p. 3041-3044 (26 juin 1967).
Smith, S. W. Visual Noise, Energy-Sensory Effect Transformation Function, and Detection and Brightness Discrimination of Light Flashes at Threshold and Suprathreshold Levels. Inst. for Res. in Vision, OSU, March 1967.
And about 25 additional publications.

Junius Snell, Professor

Izaki, K. and Snell, J. F. The Failure of Tetracycline to Bind to Escherichia Coli Ribosomes, Biochem. Biophys. Acta 103, 532 (1965).
Bhattacharyya, R. N. and Snell, J. F. The Swelling of Mitohondria Produced by Tetracyclines, Abstracts, ACS, 1965.
Snell, J. F. Biosynthetic Pathways. Vol. I. Part A Antibiotics, Academic Press, 1966.
And about 30 additional publications.

Richard W. Stow, Associate Professor

Stow, R. W. and Schieve, J. F. Measurement of Blood Flow in Minute Volumes of Specific Tissues of Man. J. Appl. Physiol. 14, 215-224, (1959).
Stow, R. W. Thermal Measurement of Tissue Blood Flow. Trans N. Y. Acad. Sci. Ser. II. (1965) 27, 748-758.
And about 10 additional publications.

Quentin Van Winkle, Professor

W. E. Ditmars, Jr. and Q. Van Winkle, Comparative Study of Pheophytin a and Pheophytin b Monolayers, J. Phys. Chem. 72, 39-45 (1968).
J. R. Larry and Q. Van Winkle, Charge Transfer Interactions of Chlorophylls a and b and Pheophytins a and b with sym-Trinitrobenzene, J. Phys. Chem. 73, 570-580 (1969).
L. M. Chan and Q. Van Winkle, Interaction of Acriflavin with DNA and RNA, J. Mol. Biol. 4-, 491-495 (1969).
And about 50 additicnal publications.

APPENDIX C

Biophysics Graduates

Physiology Department's Biophysics Program

Master of Science

William F. V. Bennett	1953	Captain, United States Navy
William Gannon	1954	Aeromedical Research Laboratory United States Air Force
Judson C. Hickey	1955	Associate Professor, College of Dentistr The Ohio State University

Doctor of Philosophy

Tam Farzeneh	1953	Chairman, Department of Biophysics University of Shiraz, Iran
James E. Randall	1955	Professor, Department of Physiology & Biophysics, Indiana University, Bloomington, Indiana
George Fukuyama	1956	Faculty, University of British Columbia
Arthur Eberstein	1957	Associate Professor, Institute Rehabilitating Medicine, New York University
Robert L. Farrow	1958	Assistant Professor, University of Puerto Rico
Howard M. Yanof	1960	Associate Professor, Department of Physiology Medical College of Ohio at Toledo
Jan West	1963	Assistant Professor, University of Illinois

Academic Faculty of Biophysics

Doctor of Philosophy

E. Kenneth Greenwald	1967	Assistant Professor, University of Missouri

APPENDIX D

Summary of Biophysics Teaching Programs at OSU

Year	Administrative Organization	Faculty Paid	Faculty WOC	Different Courses Approved	Courses Given	Students** S.	Students** M.	Students** D.	Students** T.	Degrees Awarded M.Sc.	Degrees Awarded Ph.D.
1951-1956	Biophysics option in Physiology	1-2	1-2	0	0						6
1957-1961	Biophysics Division in Physiology	2	2	3	3					4	3
1961-1965	Committee on Biophysics, Graduate School	0	4-3	0	0					0	0
Autumn 1964		0	4	5	2	0	2	1	3	0	0
Winter 1965		0	3	5	2	1	2	2	5	0	0
Spring 1965		0	3	5	3	2	2	2	6	0	0
1965-1966	Division of Biophysics, Graduate School										
Autumn 1965		4	2	5	5	3	2	3	8	0	0
1966-1967	Division of Biophysics, College of Biological Sciences	4	4	5	5	5	2	3	10	0	0
1967-	Academic Faculty of Biophysics College of Biological Sciences										
1967-68		3	7	5	5	3	1	6	10	0	1
1968-69		6	10	13	15	1	2	6	9*	(1)	(1)
1969-70	Estimated continuing	6	10	18	(19)	0	1	6	7	0	(3)
"	(Proposed new faculty)	(1)			(1)						
"	(New student applications						1	14	(15)		

* Of the previous year's students, two left for industry and one for the Peace Corps without completing their degrees.

( ) Parentheses indicate estimates

** S indicates Special, M indicates Masters, D indicates Doctoral. T indicates Total

APPENDIX E

Biophysics Budgets

Fiscal Year	1965-66	1966-67	1967-68	1968-69
Personnel	$78,985	$83,628	$90,528	$94,072
Operating	3,500	2,100	3,000	3,000
Equipment	4,533	3,500	2,415	
Equipment for New Faculty			53,685	3,385
Graduate School Contributions		600	800	800
Library	1,000	1,000	1,000	375